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Abstract

**New method of achievement and maintenance of the reliability objective of mechanical engineering products on the basis of control actions**

Practice shows, that reliability of products of mechanical engineering till 70th years of XX century was provided with constructional ways by means of increase of margin of safety, stability, use of more expensive materials, due to change of time for maintenance service etc. Reliability evaluation for such products was expert, without use of quantitative methods, and it is justified for that period.

In light of rapid technical progress and creation of rather complex technical systems the expert estimation became too subjective and inexact. Therefore at the end of 60th years of XX century there are the first theoretically developments of a quantitative estimation of reliability both at a stage of designing and calculation and in service. For that period the known method of calculation was based on a design stage only on one-parametrical probability function of reliability $P(t, \lambda)$, not dependent neither from operating conditions, nor from an actual technical condition of elements. Calculation of reliability was based on an assumption about a constancy of parameter of distribution $\lambda$=const on all period of operation and operating conditions and also actual change of a technical condition of elements in time were not taken into account. In this case reliability of a product calculated by the formula of exponential law of distribution of failures:

$$P(t, \lambda) = \exp(-\lambda t) \qquad (1)$$

where $\lambda$ =const - failure rate; t - time.

The carried out researches and results of processing of the statistical data for the long-term period testified that reliability of products essentially varies at each stage of

life cycle from designing till removal from operation. It can be presented as the diagram of change of failure rate (figure 1).

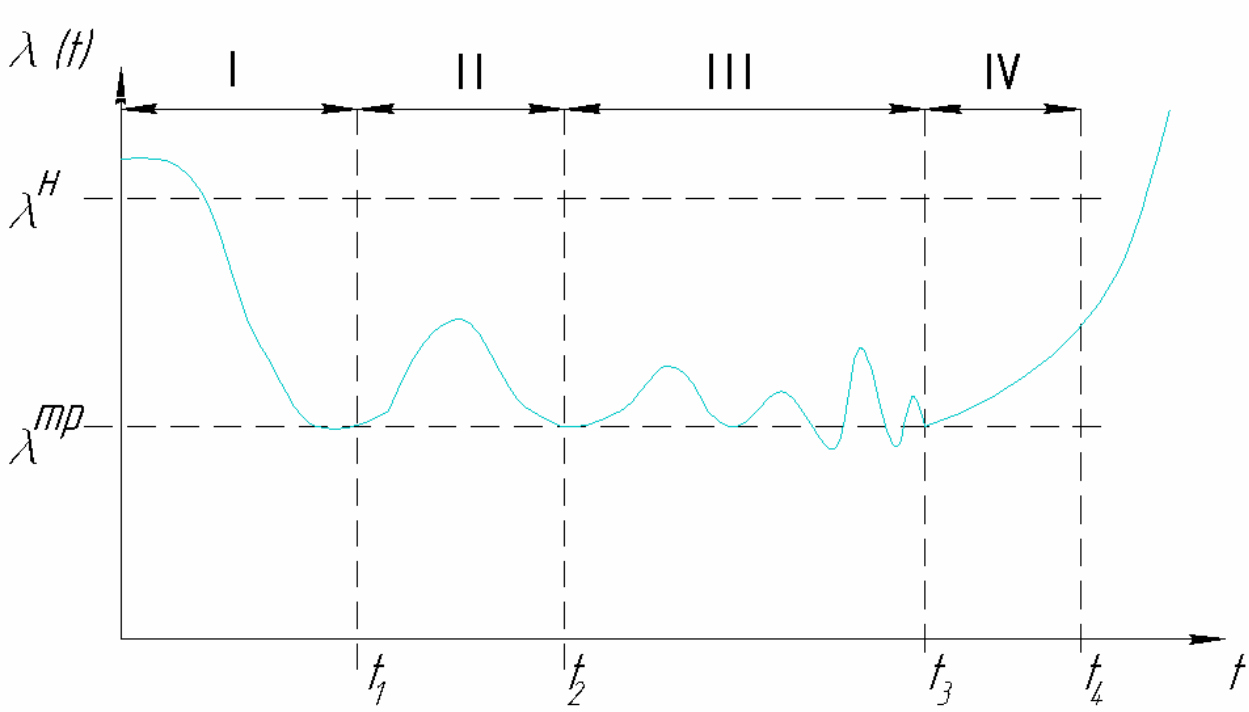


Figure 1. The diagram of change of failure rate during life cycle

$\lambda_{тр}$ - required value of failure rate;

$\lambda_{н}$ - inadmissible value of failure rate.

I - a stage of creation of a product;

II - a stage of the first years of operation;

III - a stage of a technical resource;

IV - a stage of ageing and deterioration.

We offered to use the system approach to calculation and an estimation of reliability of products by introduction of additional two-parametrical function of reliability $R(t_i, \lambda_i, a_i)$ dependent on operating conditions and actual change of a technical condition of elements in time.

In this case reliability of a product is considered as function from two components expressed by product of probabilities:

$$G(t_i, \lambda, \lambda_i, a_i) = P(t_i, \lambda)\, R(t_i, \lambda_i, a_i) \qquad (2)$$

Additional function of reliability $R(t_i, \lambda_i, a_i)$ is possible to present as some constant law of distribution which parameters $\lambda_i$ and $a_i$ depend on some determined characteristics of external conditions and the determined changes of parameters of elements (for example, change of margin of safety, deterioration, fatigue stresses, a resource etc.).

Thus, received three-parametrical probability function of reliability $G(t_i,\lambda,\lambda_i,a_i)$ specifies an expert method and one-parametrical model.

Two-parametrical function of reliability $R(t_i, \lambda_i, a_i)$ is calculated on the mathematical model representing closed system taking into account control actions, expressed obviously as constructive, technological and operation's characteristics and directly determining parameters $\lambda_i$ and $a_i$ (figure 2).

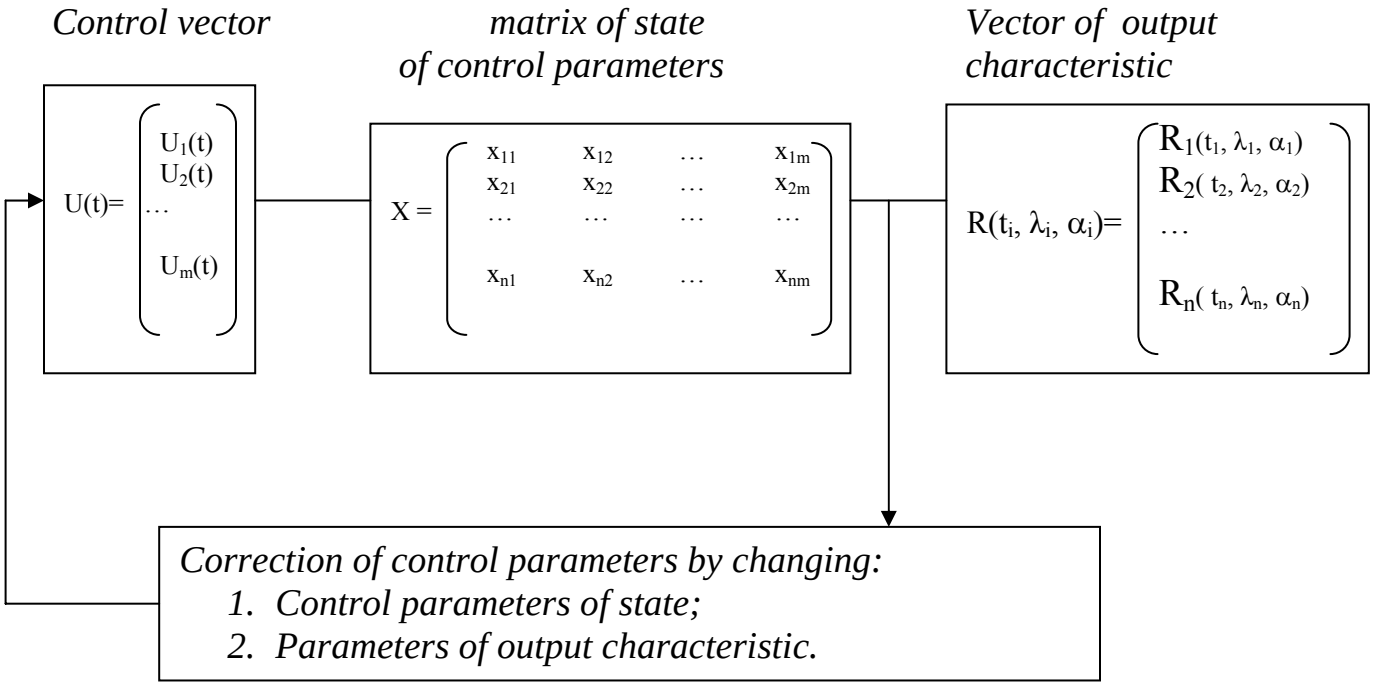


Figure 2. Closed system taking into account control actions.

The offered approach is confirmed with results of tests and operation for the long-term period of operation of complex expensive products such as a complex on hydrobreak of a layer of oil wells.